Referee's Recommendation		For [illegible]al Operation Use
Name: David R. Jun	Date: 27 July 99	Docket Number: EUS03380-RMOA
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☒ File: Disclosure Complete	☐ Do Not File (Specify Reasons)	DR1
☐ File: Prepare Full Disclosure	☐ Review Further	
☐ Publish in TDB	☐ Keep as Formal Trade Secret	
Referee's Comments:		

EXHIBIT 1

Ericsson Inc. Invention Disclosure Cover Form

1. Invention Title: Seamless Handover For Mobile Packet Data Service In Gprs 136hs Compact

2. Disclosure Submitted by (Add additional sheets if more than three inventors):

	Inventor No. 1	Inventor No. 2	Inventor No. 3
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3. Date invention conceived (mm/dd/yy) [redacted] **4. Date invention reduced to practice:**

5. Identify (including dates) any past or anticipated disclosure outside the company, such as publication, offer for sale, actual sale, discussions with business partners, etc.: The content of his invention is targeted for public disclosure on August 16, 1999.

6. Invention made using government or non-Ericsson funding?: No

7. Present or proposed use of the invention (identify products and dates): Commercial deployment of GPRS-136HS networks.

8. Identify related invention disclosures of which you are aware:

9. Pl ase attach to this cover form your invention disclosure, along with any other relevant documentation (see "IPR at RTP" Web site for additional information on writing disclosures).

The invention described in the attached invention disclosure is hereby submitted under my employment agreement with Ericsson Inc.

Inventor's Full Signature	Date	Witnessed, read, understood and signed by	Date
(1)		(1) David R. Jun	27 July 99
(2)		(2)	
(3)		(3)	

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Patent Engineering

Inventor: Submit to Kristen D Simon , Davis-2B, Cubicle #2421, x7711.

Revision: 02/04/99

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1. TITLE

Seamless Handover for Mobile Packet Data Service in GPRS 136HS COMPACT

2. INVENTORS

John Diachina and Gunnar Rydnell.

3. FIELD

The invention allows cellular phones that supports packet data service, more rapidly to make a reselection to a neighbor cell while engaged in packet data transfer.

4. SUMMARY

A Cellular Packet Data Capable Mobile may set up a packet data session in order to send and receive packet data. The mobile may connect to an Internet server providing packet data service. The connection over Internet can utilize the TCP/IP protocol for end-to-end delivery. The mobile can access the fixed network via a packet data channel on the air-interface. When roaming, the MS shall be connected at any time to the closest base station providing the best communication channel. In order to ensure that it has always selected the best cell and channel, the MS must monitor the signal strength on the adjacent cells in order to determine when a neighbor base station is stronger than the current one. When a stronger base station is detected the MS shall switch its connection to the new base station and start communicating with the new base station. This is what is normally called a handover. In the case of an MS engaged in a packet data session on a packet data channel the handover is autonomously initiated by the MS and may also be referred to as re-selection. When the MS changes its point of attachment to the new base station (i.e. it re-selects to the stronger channel), the TCP/IP connection will be moved over to the new base station by the network and the packet data session is then continued. From the mobile users point of view the packet data session shall not be affected. That is known as seamless handover.

According to the prior art the handover mechanism for an MS in active mode on a packet radio channel is such that the MS monitors the signal strength of the adjacent control channels. The MS is also required to read certain limited information on each adjacent control channel. This information is called the BSIC in GSM/GPRS and is needed in order to identify and therefore confirm that the monitored adjacent control channel is the intended one. The information about which adjacent control channels that the MS has to monitor is distributed to the MS in a neighbor cell list message (broadcasted on the control channel in the current cell). When any adjacent control channel becomes the strongest, the MS makes the decision to switch to that new channel. Then the MS must synchronize to the new channel and read broadcast information thereon prior to doing anything else. Only then is the MS allowed and able to make an access on the new channel in order to make itself known to the system. After that, the network is able to switch the connection to the MS to the base station serving the new control channel and can start forwarding data to and from the MS via the new control channel. However, there is a problem with this method in that it might consume some considerable amount of time during the handover process. During this time the MS is out of reach and no data can be sent to or received from the MS. It is a well-known problem that the TCP protocol flow control mechanism is not well suited to radio channel communication. During the handover process, while the MS is out of reach, the TCP peers will not be able to send and receive payload and control information as required for optimal performance. TCP protocol timers may expire and the TCP flow control algorithm may slow down the throughput and go into recovery mode. This will result in a slow start up mode when the MS eventually completes the re-selection and the MS user will therefore experience degraded throughput. The TCP connection might even be lost and the session taken down. All this will result in a perceivable degraded service for the end user. In the interest of enhancing the grade of service provided to users, it is important to minimize the amount of time the MS will be out of reach while performing a re-selection during a packet data session (i.e. while in the active mode).

A new method, according to this invention, is designed to speed up the handover process while changing control channels . One part of the current handover process is for the MS to read broadcast information after synchronizing to the new control channel . If this reading of broadcast information was not required in the period immediately following synchronization to the new control channel but prior to performing an attach procedure thereon, the handover would be faster. In traditional cellular packet data systems such as GPRS, the only method to acquire the system information is to read it on the new control channel after switching to it and acquiring synchronization. However, when the base stations in the different cells are synchronized (i.e. the transmission of TDMA frames, multi-frames and hyperframes are synchronized), it is possible for the MS to read broadcast information on adjacent control channels prior to switching to and acquiring synchronization on any of these control channels. This is

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because the MS know when the adjacent control channels are transmitting broadcast information, since their multiframes are synchronized to the current control channels.

In addition, due to the Time group concept of EDGE Compact, control channels associated with any given channel frequency are divided into time groups in order to support a required frequency reuse planning. According to this concept a given control channel transmits broadcast information on its assigned time group but must not transmit anything during any time group allocated to another adjacent control channel using the same frequency.. Thus the MS is therefore not supposed to receive anything during the time groups assigned to other control channels using the same channel frequency. Also, there is in the newly proposed compact system for which the last burst of a multi-frame contains a PSCH (Packet Synchronization) block. During the PSCH block the MS can synchronize to any adjacent control channel. This means that the MS can read the broadcast blocks in an adjacent control channel while it is in the IDLE or ACTIVE mode on the current channel (i.e. prior to switching to the new cell). In this way, the MS can have already read all of or at least the essential part of the system information associated with the new control channel at the point when the re-selection decision is made. After synchronizing to the new channel the MS can therefore immediately access the radio channel and make itself known to the network, which is then able to immediately switch the MS connection to the base station serving the new control channel and start forwarding data to and from the MS.

Compared to the prior art, this handover method is faster and can result in a noticeable increase in service quality for the end-user while engaged in a packet data TCP/IP session.

5. PRIOR ART

According to the prior art the following procedure is required for re-selecting to an adjacent packet channel while in active (READY) mode:

1. An MS is active on a radio Packet Data Channel served by a SGSN. It has already performed a successful GPRS attach procedure. During IDLE periods the MS performs a monitoring of adjacent cells signal strength in order to determine when a neighbor base station becomes stronger than the current one.
2. When a reselection criterion indicating that a stronger neighbor exists and that other certain conditions are met, the MS starts to re-select.
3. The MS reselects and synchronizes to the new cell's radio Packet Data Channel and reads a full cycle of broadcast information. The broadcast information may include:
   - The system identification information
   - The channel specific access and other protocol parameters
   - The neighbor list
   - The serving cell's list of coincidental DCCH coverage
   - Routing Area Identity (RAC+LAI)
4. The MS acquires services on the new serving radio Packet Data Channel and automatically resumes transmission on the new channel by transmitting an uplink LLC frame of any type containing the MS's identity. The BS shall add the identifier of the cell to all higher layer protocol frames, *i.e.*, BSSGP, transmitted towards the SGSN. The SGSN notices the cell update as the BSSGP header contains the cell identifier of a new cell. From the SGSN perspective, the cell update consists of any correctly received and valid LLC PDU carried inside a BSSGP PDU.
5. The SGSN records this MS's change of cell, and further directs traffic towards the MS over the new cell. The SGSN is responsible to buffer and retransmit LLC frames, when acknowledged mode is used.

The time required reading the broadcast information on the new channel depends on the amount of system information present. However, a typical value, not a maximum value, may be that the cycle of broadcast information is 8 multi-frames. A multi-frame is 240 ms, so the time it takes to read the system information is then 2 s. If the cycle time is more than 8 multi-frames, the time the MS is unreachable can be even longer.

6. DESCRIPTION

According to the new method described in this invention the following procedure is required for re-selecting to an adjacent packet channel while in active (READY) mode:

1. An MS is active on a radio Packet Data Channel served by a SGSN. It has already performed a successful GPRS attach procedure.

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2. During IDLE periods the MS performs monitoring of adjacent cells signal strength in order to determine when a neighbor base station becomes stronger than the current one. During an IDLE period, for a neighbor control channel that is considered to be a potential re-selection candidate and is transmitting synchronized broadcast information, the MS tries to decode the neighbor PBCCH. The MS tries to read a full cycle of broadcast information. A neighbor may be considered as a potential re-selection candidate when it is present in the list of the N strongest neighbors, or when it meets a narrower signal strength criterion indicating that it will soon be selected as the re-selection candidate.
3. When a reselection criterion indicating that a stronger neighbor exists and that other certain conditions are met, the MS starts to re-select.
4. The MS reselects and synchronizes to the radio Packet Data Channel of the new control channel.
5. The MS acquires services on the new serving radio Packet Data Channel and automatically resumes transmission on the new channel by transmitting an uplink LLC frame of any type containing the MS's identity. The BS shall add the identifier of the cell to all higher layer protocol frames, *i.e.*, BSSGP, transmitted towards the SGSN. The SGSN notices the cell update as the BSSGP header contains the cell identifier of a new cell. From the SGSN perspective, the cell update consists of any correctly received and valid LLC PDU carried inside a BSSGP PDU.
6. The SGSN records this MS's change of cell, and further directs traffic towards the MS over the new cell. The SGSN is responsible to buffer and retransmit LLC frames, when acknowledged mode is used.

The time required to read the broadcast information on the new channel is saved when using this handover method. This is because the broadcast information is read in the background during step 2. In step 3 the only action required of the MS is to synchronize to the new channel.

Note that, also in a system where the re-selection mechanism is such that the active MS is not required to read system information on the new channel after reselection prior to making a random access, the new method described here is applicable and beneficial. In such a system it would be required that the necessary information for all neighbor cells is broadcasted in the Neighbor List in the old cell. In this way the MS would have the necessary information available at reselection. However, broadcsting information in the Neighbor List is expensive in terms of bandwidth. If the MS were able to read broadcast from neighbors according to the new method proposed here, thes information would not have to be sent in the broadcasted Neighbor List for all neighbors. In terms of benefits is readily seen that in such a system, even if the actual reselection process would not be faster using the new method, more bandwidth would be available for data traffic since duplicate information would not be broadcasted. In that way the operator would benefit, even if the end user would not directly experience better service.

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